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In making or reducing meteor observations, note on a single night, or on two or three consecutive evenings, it is always best to map the results *at once*, and either to endeavour to determine any new radiant, or to correct the position of old-established ones; making use of this catalogue as a guide, rather than as an end. There being doubtless a tendency for particular meteor-showers to appear most strongly marked on certain special dates, it will thus be possible to determine the position of their radiant points more accurately than they are frequently at present known. Observations specially directed towards the supposed position of a radiant will also best show the shorter tracks, which are best calculated to determine the precise position of the radiant point of any particular meteor-shower: and the characteristic features of speed or duration, brightness, colour, and of the attendant sparks or streak of meteors belonging to different showers should at the same time be very carefully recorded, and considered in distinguishing the radiant points from which they probably diverged. The radiant V, and probably also T G (No. 78), seems to have appeared somewhat prominently only during the last two or three years; whilst the neighbouring radiant T 1 (No. 67), formerly a prominent feature, especially during the August period, and giving meteors considerably less rapid in their flight than the Perseids, have been less noticeable. Those meteor-showers, at present most clearly marked and contemporaneous with the greater 7–12th August period, are V; T G (78); N 12, 13; E 1 (90); B 3; H (77); B 4 (68); T 1 (67); and in mapping the meteors at that period it will be well to bear those radiants in mind whilst attempting to fix with any degree of precision the true radiant centre (probably in itself not a fixed or precise one) of the Perseids themselves. The series of well-marked and nearly contemporaneous meteor-showers from July to September, with radiant centres some 15°–20° around, is near *α Cephei*, including E 1; E 2; B 1, and B 4 of Greg and Herschel; B 3, B 4, and B 5 of Heis, and mostly corroborated by the Italian observers, are deserving of more study, whether as to precise duration or exact position of radiant centres and connexions with each other; or as appertaining to a single multiple radiant, or to several distinct centres of radiation.

R. P. G.

Observations of Meteor Showers, supposed to be connected with Biela's Comet. By Prof. A. S. Herschel, F.R.A.S.

In a recent publication by Dr. Weiss[*] on the lately discovered connexion between the appearances of meteoric showers and the orbits of certain comets, a suggestion of some importance to observers of shooting stars is offered, to which the present year

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[*] *Beiträge zur Kentniss der Sternschnuppen;* Vienna Acad. Sitzungsbericht, vol. lvii. 1868.

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affords a most suitable opportunity for directing their attention. It is well known that on the occasion of its perihelion return in the year 1832, it was pointed out by Olbers that the nucleus of Biela's comet would pass within 20,000 miles of the Earth's orbit, at a point which the Earth would occupy on about the 3rd of December in that year. Had the comet passed its descending node on that date, instead of actually about one month earlier, some particles of its substance would doubtless have entered into collision with the Earth's atmosphere, and would probably have given rise to a considerable meteoric shower. The direction of their motion relatively to the Earth (or the radiant point of the cometary shower) would, it is calculated by Dr. Weiss have been, in that case, from a point in about R.A. 23°, N. Decl. 47°; and this point would have appeared to be the centre of divergence of a shower of shooting stars. It is remarkable that a meteoric shower having nearly this radiant point has been repeatedly observed since the earliest recorded appearance of Biela's Comet, on the nights of the 6th or 7th of December, of whose appearance previously to that time no record is known to exist, although a search for its occurrence was made by Prof. Newton in the best, and most extensive catalogue of meteor-showers of earlier dates.* Its first, and apparently most brilliant display was observed by Brandes, in Germany, in the year preceding the appearance of the great November star-shower recorded by Humboldt and Bonpland in America at the end of the last century, of which shower, to judge from the description of it given by Brandes, it was, indeed, by no means an insignificant precursor. It was afterwards reobserved on the same date (December 7th) in the year 1830, in France; and again in France, Belgium, and the United States in 1838, the meteors being on this occasion about four times as frequent as on an ordinary night; and by Prof. Heis at Aix-la-Chapelle in 1847, since which time no distinct account of its reappearance on the same dates seems to have been recorded. The date of its appearance in each of the years 1838 and 1847, was on the evening of the 6th of December.

At its return in 1838, the position of its radiant point was fixed by Herrick, in the United States, as in some part of *Cassiopeia's* Chair; by M. Flaugergues in France, somewhat south of this, in *Andromeda;* and by M. Bouvy, at the observatory at Brussels, near the zenith, which was there situated at the time of the observation between *Cassiopeia* and *Andromeda*. Its approximate position, as noted by Prof. Heis at Aix-la-Chapelle, in 1847, was at a point in R.A. 25°, N. Decl. 40°, not far from the star of γ *Andromedæ*. Later observations appear to have led Prof. Heis to adopt a more northerly position (A 19 in his later list of radiant points for December) at R.A. 21°, N. Decl. 54°. This shower is therefore as totally distinct, both in its date and comparatively rare returns, as in the position of its radiant point from the far older, annually recurring, and

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* *American Journal of Science*, Second Series, vol. xxxvi., p. 145, *et seq.*

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better known meteor shower of the 12th of December, whose radiant point has recently been determined with certainty and precision in the neighbourhood of *θ Geminorum*, in R.A. 105°, N. Decl. 30°. As shown by Prof. Newton in his already mentioned research, the earlier appearances of this shower also extend backwards as far as the year A.D. 901.

A radiant point of several shooting stars, observed by Mr. Zezioli in Italy on the evening of November 30, 1867, is contained in Prof. Schiaparelli's list of radiants derived from Mr. Zezioli's observations (as shown in Mr. Greg's comparative table) at R.A. 17°, N. Decl. 48°, near *θ Cassiopeiæ*. An elongated region of radiation of shooting stars, lasting for a long period until near the end of November (A 14, 15 in the English list), is there also placed by Mr. Greg close to the position of the radiant A 19 of Prof. Heis, although preceding it considerably in point of time. But it appears not impossibly to be connected by intermediate meteors with the succeeding radiant A 16 in the same list, whose position is somewhat too distant to be included in the former group. The node of the orbit of Biela's comet possessing an extremely rapid retrograde motion, so that the date of the Earth's passage through it now falls in the end of November instead of in the beginning of December, it appears probable that the dates of the last two meteoric showers, although not coinciding with the 6th or 7th of December, may yet have belonged to returns of the cometary meteor group. The following longitudes and dates of the Earth's passage through the node, and the corresponding positions of the cometary radiant point from the earliest to the latest recorded appearances of Biela's comet, were calculated by Dr. Weiss from Hubbard's elements of the comet's orbit at those times of its appearance. The mean motion of the node of a meteoric cloud revolving in the same orbit as that of Biela's comet, arising from the planetary perturbations, if calculated in the same manner for the 7th of December meteors as that calculation was successfully accomplished by Prof. Adams for the December meteor group, would indicate, as suggested by Dr. Weiss, the extent to which such a meteor cloud may be expected to participate with Biela's comet in the rapid retrograde displacement of its node.

Year of Observation.	Longitude of Desc. node. (1850·0).	Date of Earth's Passage through Node.	Position of Cometary Radiant Point.		Velocity of the Meteor relatively to the Earth.
			R.A.	N. Decl.	
A.D. 1772	258°·4	Dec. 10	18°·7	58°·1	9·6 miles per second.*
" 1826	251·8	Dec. 4	22·8	47·7	9·6 " "
" 1852	245·8	Nov. 28	23·4	43·0	9·7 " "

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* These velocities are without allowing for the effect of the Earth's attraction. When this is taken into consideration the relative velocity of the meteors of Biela's comet is found to be 11·9 miles per second, while that of the Leonids, or meteors of the November shower, is 44·3 miles per second.

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Owing to the comet's motion in its orbit, and that of the Earth being in the same direction, and but slightly inclined to each other (about 22°), at their point of nearest approach, the case of this meteor stream overtaking the Earth is a somewhat extreme example of the opposite kind to that of the November meteor current, which meets the Earth with a small inclination to its course, moving in an opposite direction. The speed with which the meteor particles of Biela's Comet enter the Earth's atmosphere (allowing for the effect of the Earth's attraction) is thus little more than a fourth part of that with which the November meteors first penetrate it. Their radiant point is, for the same reasons, more westerly than those of ordinary meteor showers, arriving near the zenith at Greenwich soon after eight o'clock in the evening, and descending towards the north-west and north horizon (where it is circumpolar) during the later hours of the night. In its approach to the northern horizon (should the meteors be observed in the early morning hours), the effect of the Earth's attraction upon their nearly horizontal courses, owing to the extremely low relative velocity presented in the case of this westerly meteor current, is so considerable that the apparent radiant point is raised about 10° from the apparent position which it has when the radiant point of the shower is in the zenith.

Besides the disruption of Biela's comet into two parts, which was witnessed during its reappearance in the year 1832, it is observed by Dr. Weiss that the approximate orbit of the telescopic Comet I. 1818, appears to coincide so nearly with that of Biela's comet, that should it be a fragment of that comet formerly separated from its principal body, and now revolving in nearly the same periodic time with it, but passing its perihelion somewhat more than one year earlier than Biela's Comet, the star-showers of December 1798 and 1838, would be found to coincide with the dates of perihelion passage of this companion comet at the beginning of those years in the same way that the great star-showers of August 1863, and November 1866, followed quickly after the appearances of the Comets III. 1862, and I. 1866. In the following list of the approximate dates of the former and present passages of Biela's comet (and of Comet I. 1818) through its node, it will be seen that one of the December meteor-showers was similarly observed in 1847, following one of the nodal passages of Biela's comet in the preceding year; and that the shooting-stars from *Cassiopeia*, observed by Sig. Zezioli in Italy on the 30th of November, 1867, appeared in the year following the return of Biela's Comet to its node in the year 1866.

Should a clear sky permit a watch to be kept for these meteors during the last week in November, and the first week in December next, and especially on the nights of the 4th to the 7th of December, both in this and in next year, a favourable opportunity for verifying practically these ingenious suggestions of Dr.

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Weiss presents itself in the occasion of the present return of Biela's Comet, which it may be hoped will not escape the attention of astronomers, nor pass unnoticed by observers and recorders of meteoric showers.

	Dates and Places of Observation of the Great Meteor Shower of Brandes, of the 6th and 7th of December.	Approximate Dates of the Passage of Biela's comet (and of Comet I. 1818) through its Node.
A.D		A.D.
1798, Dec. 7	(P.M.). Great shower of meteors observed by Brandes, near Hamburg, Germany. Four hundred meteors counted in a few hours (in half of the sky, while travelling). Benzenberg, *Die Sternschnuppen.*	1799·3 (1798·1; Comet I. 1818?).
1830, Dec. 7	(P.M.). Many shooting stars seen in France, by Abbé Raillard. *Comptes Rendus*, 1839, Feb. 4.	1832·8 (1831·4; Comet I. 1818?).
1838, Dec. 6	(P.M.). Meteor shower observed in France, at Toulon, by Paul Flaugergues; and in the United States by E. C. Herrick. Seen also at Brussels, by M. Bouvy, Assistant at the Observatory, from $7^h\ 30^m$ P.M. Meteors four times as frequent as on an ordinary night, descending from *Pegasus* and *Aries* towards the S.E. and S.W. horizon from the direction of the zenith, [*i.e.*, from near *Cassiopeia; * radiant in *Cassiopeia.*] *Comptes Rendus*, 1839, Jan. 21, and Feb. 4 (*Bulletins*, Ac. Roy. de Belgique, vol. vi., No. 6, June, 1839).	1839·4 (1838·1; Comet I. 1818?).
1847, Dec. 6	(P.M.). Shower of meteors observed by Prof. Heis, at Aix-la-Chapelle. Radiant point at R.A. 25°, N. Decl. 40° [near *γ Andromedæ.*] Heis, *Die Periodische Sternschnuppen*, Cöln, 1849.	1846·1 (Biela's comet separated into two parts.
1867, Nov. 30	(P.M.). Nine meteors in two hours recorded by M. Zezioli at Bergamo, Italy; all radiating nearly from a point in R.A. 17°, N. Decl. 48°, near *θ Cassiopeiæ.* Prof. Schiaparelli; Preliminary results of Shooting-star observations made by Zezioli, Part II. *Effemerides Astronomiche del Osservatorio di Milano*, 1871.	1866·0 (Biela's comet not seen since 1852. Present nodal passage of [Biela's comets 1872·7; of Comet I. 1818, 1871·4?).

Dr. Huggins's Spectroscopic Observations of Stars and Nebulæ.

Dr. Huggins has communicated to the Royal Society a series of results of extreme interest, obtained by means of the fine telescope placed at his disposal by the Royal Society.

His work has been divided into two main portions. First, he has been engaged in comparing one of the bright spectral lines of

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the gaseous nebulæ with the corresponding line in the spectrum of nitrogen. This line, as seen in the latter spectrum, is double. When using his own 8-inch telescope, Dr. Huggins was unable to determine whether the nebula line was double or not. He could not use sufficient dispersive power. He has now obtained definite results on this point, so far at least as the *Orion* nebula is concerned. In the spectrum of nitrogen the components of this double line are rather broad and nebulous. In the spectrum of the *Orion* nebula there is one line, narrow and well defined, which agrees in position with the less refrangible of the nitrogen pair. There are two available explanations of this. It may be that under certain conditions the line becomes single, occupying a position midway between the positions of the two lines, and that in the spectrum of the *Orion* nebula the line is shifted owing to the motion of the nebula. A motion at the rate of from 30 to 40 miles from the Earth would account for the displacement. Or again, it may be that under certain conditions the more refrangible line might fade out altogether. Dr. Huggins has tried the experiment, but has not been able to reduce the spectrum of nitrogen to a single line. The observations required are somewhat difficult, as the lines fade out under the change of condition which alone seems to promise to effect the simplification of the spectrum. But Dr. Huggins feels tolerably certain that the line is always double, and that there is no change in its position.

It is possible, however, Dr. Huggins remarks, that this line in the spectrum of the gaseous nebulæ is not due to nitrogen at all. Or else, one line of nitrogen fades out altogether. He proposes to compare the spectrum of nitrogen with the spectra of other gaseous nebulæ.

The second series of results obtained by Dr. Huggins relates to the determination of the stellar motions of recession or approach. In making these observations, Dr. Huggins has not trusted to the ordinary method of comparing spectra by placing a prism over one half of the slit, and so bringing the spectrum of comparison beside that of the star under examination. He points out that this method is in several respects unsatisfactory. Indeed, he did not trust solely to this method in his former observations of *Sirius*. He set a light directly opposite the object-glass of his telescope, and compared its spectrum with that of the star. But with a telescope 15 feet long, like that which he is now employing, this arrangement is not convenient, and the light is rendered by distance too faint for his purpose. He has therefore had holes drilled in the telescope tube, 30 inches from the focus, and causes a holder containing a vacuum tube to be placed exactly in the optical axis of the telescope. Instrumental means exist for accurately adjusting the vacuum tube in this position; but the accuracy of the adjustment can also be very readily tested.

Dr. Huggins had judged when he used his 8-inch telescope that *Sirius* is receding at the rate of about 25 miles per second.

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He now finds that the rate of recession is somewhat less, lying probably between 18 and 22 miles per second.

He has been able to extend this method to several other stars. He finds evidence in favour of a general tendency to recession in stars occupying that part of the heavens from which our Sun is known to be travelling; while on the opposite side of the heavens the stars seem in general to be approaching. But the rates of recession and approach accord very ill with the usually adopted value of the solar proper motion, and appear to support the theory recently advanced, that the estimates of the stellar distances, on which that value has been based, are not trustworthy. We know that the Sun's rate of motion has been set at five or six miles per second, and such a rate of motion could only account for a general excess of recession in stars lying in one direction, and of approach in stars lying in the opposite direction, by about the same amount. But Dr. Huggins finds motions of recession of from 15 to 28 miles per second, and motions of approach amounting even to the enormous rate of 55 miles per second in the case of *Arcturus*. It would seem to follow from this that Struve's estimate of the average distances of the brighter stars is altogether too low.

The following tables are from Dr. Huggins's paper:—

Table I. Stars moving from the Sun.

Star.	Compared with	Apparent Motion.	Earth's Motion.	Motion from Sun.
Sirius	H	26 to 36	−10 to −15	18 to 22
Betelgeux	Na	37	−15	22
Rigel	H	30	−15	15
Castor	H	40 to 45	−17	23 to 28
Regulus	H	30 to 35	−18	12 to 17
β Urs. Maj.	H	30	−9 to −13	17 to 21
δ —	H			
ε —	H			
γ —	H			
ζ —	H			
β Leonis	H			
δ —	H			
η Urs. Maj.	H			
α Virginis	H			
α Coronæ B.	H			
Procyon	H			
Capella	H			
Aldebaran (?)	Mg			
γ Cassiopeiæ	H			

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Table II. Stars approaching the Sun.

Star.	Compared with	Apparent Motion.	Earth's Motion.	Motion towards Sun.
Arcturus	Mg	50	+ 5	55
Vega	H	40 to 50	+ 3·9	44 to 54
α Cygni	H	30	+ 9	39
Pollux	Mg	32	+17	49
α Ursæ Maj.	Mg	35 to 50	+11	46 to 61
γ Leonis	Mg			
ε Bootis	Mg			
γ Cygni	H			
α Pegasi	H			
γ Pegasi (?)	H			
α Andromedæ	H			

It will be seen that the five stars β, γ, δ, ε, and ζ, are all receding at the rate of about 30 miles per second. Moreover, Dr. Huggins finds that the spectra of all these stars present similar characteristics, the lines of hydrogen being very broad and strong. In η *Ursæ Majoris* the line of hydrogen is not so strong or so broad, nor is η receding at the same rate; so that clearly this star does not belong to the same set. The star α *Ursæ* is found to have a spectrum markedly different from that common to β, γ, δ, ε, and ζ, and to be approaching the Earth instead of receding. This agrees with the theory recently advanced, that the five stars, β, γ, δ, ε, and ζ, form a drifting group of stars.

Sweeping Ephemerides for the Comet of Biela, including the Period of Absence of Moonlight in the Morning Sky in October. By J. R. Hind, Esq.

1872. 9^h 36^m G.M.T.	Perihelion, Sept. 28·4.		Perihelion, Oct. 6·4.			Perihelion, Oct. 14·4.	
	R.A.	Decl.	R.A.	Decl.	Δ	R.A.	Decl.
	h m	° ′	h m	° ′		h m	° ′
Sept. 28	10 4·0	+6 27	9 43·0	+9 15	1·345	9 20·3	+12 22
30	13·0	5 21	9 52·4	8 6		30·2	11 9
Oct. 2	21·9	4 15	10 1·7	6 56	1·365	40·0	9 56
4	30·7	3 9	10·9	5 46		49·7	8 42
6	39·3	2 4	19·9	4 37	1·388	9 59·2	7 28
8	47·8	+1 0	28·8	3 28		10 8·6	6 15
10	10 56·2	−0 3	37·6	2 20	1·414	17·8	5 2
12	11 4·5	1 4	46·2	1 13		26·9	3 50
14	12·6	2 5	10 54·8	+0 7	1·442	35·8	2 38
16	20·6	3 4	11 3·2	−0 58		44·6	1 27
18	11 28·5	−4 2	11 11·4	−2 2	1·472	10 53·3	+ 0 18

Mr. Bishop's Observatory,
Twickenham, 1872, *Sept.* 17.